

What is claimed is:

- 1 1. A bone fixation apparatus for a rod system comprising:
  - 2 a bone anchor having a proximal end for engaging a driving device and a distal end
  - 3 for engaging a bone;
  - 4 a housing coupled to said proximal end of said bone anchor having opposed spaced-
  - 5 apart flanges extending longitudinally defining a channel therebetween for receiving a rod,
  - 6 said flanges having an outer surface and an inner surface having female threads therein;
  - 7 a locking assembly for locking said surgical rod to said housing in contact with
  - 8 said proximal end of said bone anchor;
  - 9 wherein said locking assembly further comprises an upper cap and a lower cap
  - 10 joined by a post and rotatable relative one to the other, wherein said upper cap is a generally
  - 11 cylindrical member having an outer surface containing threads thereon and an inner cavity
  - 12 and an upper surface and a lower surface and wherein said inner cavity further comprises an
  - 13 opening to receive said post; and wherein said lower cap comprises an upper surface and a
  - 14 lower semi-cylindrical surface for engaging said rod; and
  - 15 wherein said rod is insertable into said channel of said housing and said locking
  - 16 assembly is thereafter insertable into said channel of said housing, and wherein a driving
  - 17 instrument is insertable into said inner cavity of said upper cap and rotates said upper cap
  - 18 relative to said lower cap about said post, thereby engaging said threads, thus causing said
  - 19 locking assembly to translate longitudinally toward said distal end of said anchor into a
  - 20 forcing relationship with said rod, thus forcing said rod into a locking relationship with said
  - 21 proximal end of said anchor.
2. The bone fixation system of claim 1 wherein said bone anchor is a screw.
3. The bone fixation apparatus of claim 2 wherein said housing is fixed to said proximal end of said bone anchor so as to prevent angulation of said bone anchor.
4. The bone fixation system of claim 3 wherein said lower cap further comprises an extension of said lower semi-cylindrical surface dimensioned to reside within said channel.

5. The bone fixation system of claim 4 wherein said threads on said upper cap and said threads in said flanges further comprise at least one start thread timed to properly engage each other when said extension is located within said channel.
6. The bone fixation system of claim 1 wherein said bone anchor is a hook.
7. The bone fixation apparatus of claim 6 wherein said housing is fixed to said proximal end of said hook so as to prevent angulation thereof.
8. The bone fixation system of claim 7 wherein said lower cap further comprises an extension of said lower semi-cylindrical surface dimensioned to reside within said channel.
9. The bone fixation system of claim 8 wherein said threads on said upper cap and said threads in said flanges further comprise at least one start thread timed to properly engage each other when said extension is located within said channel.
10. The bone fixation system of claim 1 wherein said bone anchor is a polyaxial screw further comprising a head disposed at said distal end having a conic or aspheric upper surface and a partially spherical lower surface and defining a periphery at a junction of said upper and lower surfaces.
11. The bone fixation system of claim 10 wherein said lower cap further comprises an extension of said lower semi-cylindrical surface dimensioned to reside within said channel.
12. The bone fixation system of claim 11 wherein said threads on said upper cap and said threads in said flanges further comprise at least one start thread timed to properly engage each other when said extension is located within said channel.
13. The bone fixation system of claim 12 wherein said proximal end of said polyaxial screw further comprises a depression disposed about said periphery.
14. The bone fixation system of claim 13 wherein said inner surface of said flanges further comprise an appurtenance projecting substantially radially inwardly.

15. The bone fixation system of claim 14 wherein said polyaxial screw is removable from said housing when said depression aligns with said appurtenance, but is not removable when said depression is not aligned with said appurtenance.

1 16. A bone fixation apparatus for a rod system comprising:

2 a bone anchor having a proximal end for engagement with a driving device and a  
3 distal end for engagement with a bone;

4 a housing coupled to said proximal end of said bone anchor having opposed  
5 spaced-apart flanges extending longitudinally and having a channel therebetween to receive  
6 a surgical rod therein, each flange having an outer surface and an inner surface and an  
7 undercut within said inner surface;

8 a locking assembly for locking said surgical rod to said housing in contact with said  
9 proximal end of said bone anchor, further comprising an upper cap and a lower cap joined  
10 by a post and rotatable relative one to the other, wherein said upper cap is a generally  
11 cylindrical member having an outer surface and an inner cavity and an upper surface and a  
12 lower surface having camming surfaces thereon and wherein said inner cavity further  
13 comprises an opening to receive said post; wherein said outer surface has a first wing and a  
14 second wing projecting radially outwardly therefrom for insertion into said undercut to  
15 prevent removal of said locking assembly; and wherein said lower cap further comprises an  
16 upper surface having camming surfaces thereon for engagement with said camming surfaces  
17 of said upper cap and a lower semi-cylindrical surface for engaging said rod;

18 wherein said rod is insertable into said channel of said housing and said locking  
19 assembly is thereafter insertable into said channel of said housing, and wherein a driving  
20 instrument is insertable into said inner cavity of said upper cap and rotates said upper cap  
21 relative to said lower cap about said post, thereby moving said camming surfaces of said  
22 upper cap relative to said camming surfaces of said lower cap, thus causing said lower cap  
23 to translate longitudinally toward said distal end of said anchor into a forcing relationship  
24 with said rod, thus forcing said rod into a locking relationship with said proximal end of said  
25 anchor.

17. The bone fixation apparatus of claim 16 wherein said bone anchor is a screw.

18. The bone fixation apparatus of claim 17 wherein said housing is fixed to said proximal end of said bone anchor so as to prevent angulation of said bone anchor.

19. The bone fixation apparatus of claim 18 wherein said undercut further comprises a slot adjacent thereto disposed radially outwardly of said undercut having an inner surface and an outer surface and longitudinal dimension greater than that of said undercut.
20. The bone fixation apparatus of claim 19 wherein said first wing and said second wing further comprise ridges located outwardly thereof.
21. The bone fixation apparatus of claim 20 wherein said ridges engage said inner surfaces of said slots in said flanges to prevent splaying.
22. The bone fixation apparatus of claim 21 wherein said post further comprises a first timing groove and a second timing groove disposed longitudinally thereon.
23. The bone fixation apparatus of claim 22 wherein said upper cap further comprises a projection in said opening.
24. The bone fixation apparatus of claim 23 wherein said upper cap and said first and second timing grooves are timed such that said projection mates with said first timing groove when said locking assembly is in an unlocked position and mates with said second timing groove when said locking assembly is rotated to a locked position.
25. The bone fixation apparatus of claim 24 wherein said upper cap further comprises a stop disposed adjacent said upper surface thereof and projecting radially outwardly from said outer surface of said upper cap, said stop being located out of phase with said wings.
26. The bone fixation apparatus of claim 25 wherein said housing further comprises a depression disposed about said inner surface of said flanges.
27. The bone fixation apparatus of claim 26 wherein said stop engages said depression when said upper cap is rotated into a locked position.
28. The bone fixation apparatus of claim 16 wherein said bone anchor is a hook.

29. The bone fixation apparatus of claim 28 wherein said housing is fixed to said proximal end of said bone anchor so as to prevent angulation of said bone anchor.

30. The bone fixation apparatus of claim 29 wherein said undercut further comprises a slot adjacent thereto disposed radially outwardly of said undercut having an inner surface and an outer surface and longitudinal dimension greater than that of said undercut.

31. The bone fixation apparatus of claim 30 wherein said first wing and said second wing further comprise ridges located outwardly thereof.

32. The bone fixation apparatus of claim 31 wherein said ridges engage said inner surfaces of said slots in said flanges to prevent splaying.

33. The bone fixation apparatus of claim 32 wherein said post further comprises a first timing groove and a second timing groove disposed longitudinally thereon.

34. The bone fixation apparatus of claim 33 wherein said upper cap further comprises a projection in said opening.

35. The bone fixation apparatus of claim 34 wherein said upper cap and said first and second timing grooves are timed such that said projection mates with said first timing groove when said locking assembly is in an unlocked position and mates with said second timing groove when said locking assembly is rotated to a locked position.

36. The bone fixation apparatus of claim 35 wherein said upper cap further comprises a stop disposed adjacent said upper surface thereof and projecting radially outwardly from said outer surface of said upper cap, said stop being located out of phase with said wings.

37. The bone fixation apparatus of claim 36 wherein said housing further comprises a depression disposed about said inner surface of said flanges.

38. The bone fixation apparatus of claim 37 wherein said stop engages said depression when said upper cap is rotated into a locked position.

39. The bone fixation apparatus of claim 17 wherein said housing further comprises a separable body for lockable attachment to said proximal end of said screw.

40. The bone fixation apparatus of claim 39 wherein said separable body further comprises an upper portion having an outer diameter and an inner diameter and a lower portion having an outer diameter and an inner diameter and wherein said outer diameter of said lower portion is less than said outer diameter of said upper portion.

41. The bone fixation apparatus of claim 40 wherein said lower portion further comprises fingers oriented longitudinally and extending from said upper portion terminating at a distal end, wherein said fingers receive said proximal end of said screw in varying orientations.

42. The bone fixation apparatus of claim 41 wherein said distal end of said fingers define an inner diameter and an outer diameter.

43. The bone fixation apparatus of claim 42 wherein said lower portion further comprises a ring disposed externally on said fingers and slideable from an unlocked position to a locked position.

44. The bone fixation apparatus of claim 43 wherein said inner diameter of said ring at a bottom end thereof is slightly less than said outer diameter of said fingers such that as said ring is slid from said unlocked position to said locked position, said ring imparts a radial force on said fingers, thus locking said proximal end of said screw in a given orientation.

45. The bone fixation apparatus of claim 44 wherein said undercut further comprises a slot adjacent thereto disposed radially outwardly of said undercut having an inner surface and an outer surface and longitudinal dimension greater than that of said undercut.

46. The bone fixation apparatus of claim 45 wherein said first wing and said second wing further comprise ridges located outwardly thereof.

47. The bone fixation apparatus of claim 46 wherein said ridges engage said inner surfaces of said slots in said flanges to prevent splaying.

48. The bone fixation apparatus of claim 47 wherein said post further comprises a first timing groove and a second timing groove disposed longitudinally thereon.

49. The bone fixation apparatus of claim 48 wherein said upper cap further comprises a projection in said opening.

50. The bone fixation apparatus of claim 49 wherein said upper cap and said first and second timing grooves are timed such that said projection mates with said first timing groove when said locking assembly is in an unlocked position and mates with said second timing groove when said locking assembly is rotated to a locked position.

51. The bone fixation apparatus of claim 50 wherein said upper cap further comprises a stop disposed adjacent said upper surface thereof and projecting radially outwardly from said outer surface of said upper cap, said stop being located out of phase with said wings.

52. The bone fixation apparatus of claim 51 wherein said housing further comprises a depression disposed about said inner surface of said flanges.

53. The bone fixation apparatus of claim 52 wherein said stop engages said depression when said upper cap is rotated into a locked position.



1     54.     A bone fixation apparatus for a rod system comprising:

2             a bone anchor having a proximal end for engagement with a driving device and a  
3     distal end for engagement with a bone;

4             a housing coupled to said proximal end of said bone anchor having opposed  
5     spaced-apart flanges extending longitudinally and having a channel therebetween to receive  
6     a surgical rod therein, each flange having an outer surface and an inner surface, said outer  
7     surface having a circumferential groove therein;

8             a locking assembly for locking said surgical rod to said housing in contact with  
9     said proximal end of said bone anchor, further comprising an upper cap and a lower cap  
10    joined by a post and rotatable relative one to the other, wherein said upper cap is a generally  
11    cylindrical member having an outer surface and an inner cavity and an upper surface and a  
12    lower surface having camming surfaces thereon and wherein said inner cavity further  
13    comprises an opening to receive said post; wherein said outer surface has a first wing and a  
14    second wing projecting radially outwardly therefrom for insertion into said circumferential  
15    groove in said outer surface of said housing to prevent removal of said locking assembly;  
16    and wherein said lower cap further comprises an upper surface having camming surfaces  
17    thereon for engagement with said camming surfaces of said upper cap and a lower semi-  
18    cylindrical surface for engaging said rod;

19            wherein said rod is insertable into said channel of said housing and said locking  
20    assembly is thereafter insertable into said channel of said housing, and wherein a driving  
21    instrument is insertable into said inner cavity of said upper cap and rotates said upper cap  
22    relative to said lower cap about said post, thereby moving said camming surfaces of said  
23    upper cap relative to said camming surfaces of said lower cap, thus causing said lower cap  
24    to translate longitudinally toward said distal end of said anchor into a forcing relationship  
25    with said rod, thus forcing said rod into a locking relationship with said proximal end of said  
26    anchor.